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Preliminary Analysis of the First Successful Soviet Communications Satellite

Launched 23 April 1965

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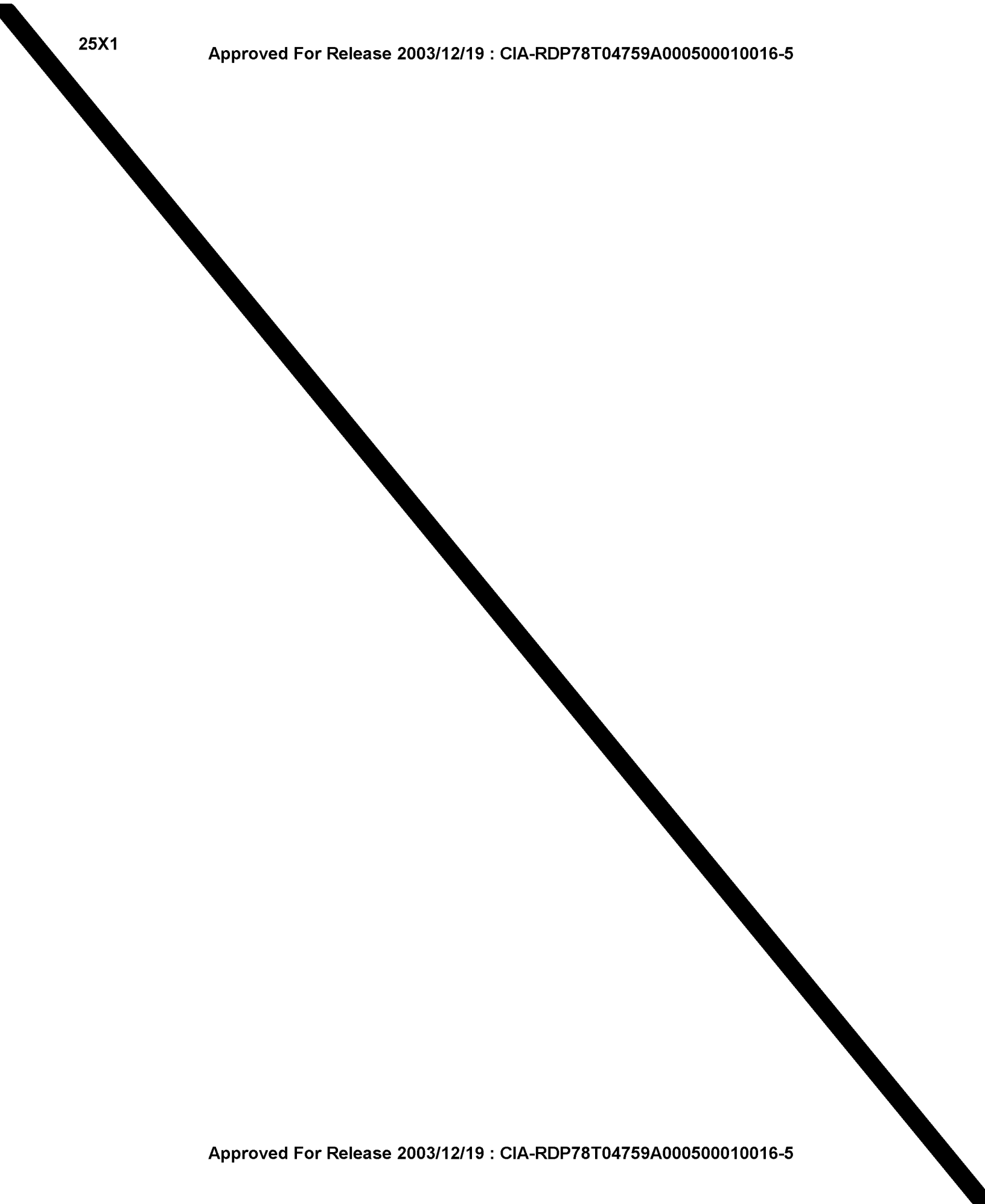

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PRELIMINARY ANALYSIS OF THE FIRST SUCCESSFUL SOVIET COMMUNICATIONS SATELLITE

SUMMARY

The successful launch of Molniya-1 on 23 April 1965 marked the entry of the Soviet Union into the field of active communication satellites. The Soviets are expected to make aggressive use of their technological accomplishments in this field and to inject themselves into international communication satellite arrangements which the United States has thus far dominated. Further launches are expected. It is likely that some of these satellites will be orbited in order to increase the period of coverage across the USSR. The flexibility of the mission design used for Molniya-1 will enable the Soviets to provide communications between other areas of the world as well as within the USSR. Because of the requirement for ground stations it is not likely the Soviets will embark on an international program outside the Soviet Bloc until Molniya technology has been fully developed and proven.

Though the orbit of Molniya-1 reveals a primary interest in coverage of the USSR, substantial periods of common visibility shared by the Soviet Union and other countries exist. Communications between the Soviet Union and several Bloc countries in Eastern Europe have already taken place. Further, it is possible that the Soviets may try to capitalize on this by making international proposals involving the use of ground stations in Western Europe or the Far East established within the COMSAT system. Problems of equipment incompatibility make this unlikely, however.

Clandestine use of the satellite in order to get communications into the USSR is possible and would not require significant ground facilities. Whether Molniya-1 is being used in this fashion, and a number of other significant questions await further information or analysis before they can be answered.

Launching of Molniya-1

An earth satellite, designated Molniya-1 (Lightning-I) was launched from Tyuratam into a highly elliptical earth orbit at 0200Z on 23 April 1965. A Tass announcement which followed the launching stated that the Soviet Union had, for the first time, relayed a television program between Moscow and Vladivostok by means of an active communications satellite, and that the satellite was capable of relaying two-way, multichannel, radio-telephone, telegraph, and facsimile transmissions. Both the spacecraft and ground stations are reportedly equipped with directional, high gain antennas. A Soviet-released conceptual sketch of the spacecraft in orbit is shown in Figure 1. Its initial orbit had

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Background to a Communications Satellite Program

This successful operation brought to a close a long period of apparent Soviet ambivalence toward the launch of active communications systems. Figure 2 shows a chronology of developments related to the emergence of this program. Soviet statements of intent to undertake such a program date back to 1961 but, until recently, were not matched by flight tests aimed at the early establishment of an operational system. The Soviets have consistently refused to become involved in any joint ventures involving active communication satellites, though the United States has made several proposals for such ventures. The last of these involved the adherence of the USSR to the COMSAT agreements, a proposal which was turned down, largely because of Soviet objections to US domination of this organization.

Economic considerations provide small justification for the independent development of satellite communications by the USSR since it feels little requirement for high traffic transoceanic links which are the most economically attractive feature of such systems and can meet its internal needs more effectively with conventional means of communication. It is clear, however, that other motives including a desire to develop a national technological capability in this area have been more important to the Soviets than these economic factors.

Facilities Construction

25X1 Evidence exists in [redacted] photography suggesting that [redacted] a Soviet 25X1D program for launching active communications satellites had begun. A study of the chronology and configuration of certain structures at satellite tracking sites at Moscow, Sary Shagan, Yeniseysk, Golenki and Khutor indicates that these facilities may be directly related to Soviet communications satellites. At each of these locations, two large buildings have been constructed with 50′ parabolic antennas either installed or being installed on the roofs. Antennas of this size would be sufficient to accomplish the transmission and reception of communications relayed by satellite. The evidence available indicates that all sites with the exception of Khutor are complete. All four seem to have 25X1D been structually completed [redacted] in sufficient time for the Cosmos 21 operation, with the Moscow and Golenki sites leading by some 6-12 months. These two sites are probably the ones used for the announced Molniya-1 television relay. Figure 3 shows a photograph of these buildings at the Khutor site with rings on the roof tops on which radomes covering the antennas will be mounted.

Flight Phase of the Program

The flight phase of the Soviet program began in November 1963 with the launch of a satellite which failed to get out of parking orbit and was designated

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Cosmos 21 by the Soviets to conceal the fact of its failure. This attempt was followed by three additional failures in February, June, and August of 1964 (see Figure 2). The last of these, Cosmos 41, achieved a final orbit very close to that of Molniya-1, but failed to perform after its final injection. The commitment of the Soviets to the fulfillment of the communications mission is reflected in this rapid and heavy expenditure of launch hardware shared by the communications satellite program with all other major Soviet space programs.

Molniya-1, like its unsuccessful predecessor, was injected into its final trajectory after a coast in parking orbit. The standard Soviet propulsion system used for all missions employing the parking orbit technique—the SS-6 booster in combination with Venik third and fourth stages was used. This combination could put as much as 4200 pounds in the Molniya-1 orbit. Analysis of propulsion telemetry from Cosmos 41 suggests, however, that the payload may weigh as little as 2000 pounds if the upper stages are not off-loaded. This figure appears equally valid for Molniya-1, though telemetry intercepts from it are not yet available for analysis.

Mission Design

The orbital design of the Molniya-1 mission is characterized by a good compromise between maximizing the weight of payload and the periods of visibility for ground stations in the USSR. The significant amount of flexibility in the design suggests that it may be used for future flights with somewhat different communications objectives.

Molniya-1 is in a nearly synchronous orbit with a period of about 12 hours. Figure 4 shows its ground track across the earth as it orbits twice each day. Its period is very nearly that required for a "repeating" earth track; i.e., one which retraces itself day after day. [redacted] 25X1D

[redacted] 25X1D

25X1D [redacted] With repeated but infrequent corrections of this type, it is possible for the Soviets to control the Eastward and Westward drift of the satellite apogee so as to maintain mutual visibility between selected points on the earth.

The apogee of Molniya-1 is near 30° North latitude, favoring coverage of Northern Hemisphere and is located longitudinally so as to be nearly optimum for coverage of the USSR. Soviet mission designers also chose the time of launch so as to get this coverage while it is mid-day in the Western Soviet Union and evening in the Far East—an arrangement which is ideal for the relay of

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television programs. Figure 6 shows the relationship of Molniya-1, the Earth and sunlight during a typical pass over the Soviet Union as it reaches its northernmost point, heads outward toward apogee, reaches it at 0800Z, and finally leaves the USSR. Figure 7 shows the periods of common visibility of Molniya-1 from a number of points on the Earth during a period of several days. The satellite is simultaneously visible to Moscow and Vladivostok daily for about 10 hours on one orbit and 1½ hours during the other. Moscow has line-of-sight visibility to the vehicle for about seven hours daily during the orbits which pass over the Western hemisphere.

Wide options are available to the Soviets for maximizing these periods of mutual visibility between various parts of the Earth through the choice of launch times, points of ejection from parking orbit, and orbital correction after final injection. Though it is clear that Molniya-1 is optimized for the relay of communications within the USSR, the degree of flexibility in the orbital design provides broad opportunities for future Soviet missions of the same type. It has, in addition, the advantage of allowing a substantially greater payload to be put in orbit than would be possible in the case of a 24-hour synchronous satellite, though at the expense of reduced periods of visibility. Because of the high latitude of Soviet launch points and the high inclinations of almost all Soviet satellites, the launch of a satellite providing 24-hour coverage would require a great expenditure of energy and, consequently, a small payload.

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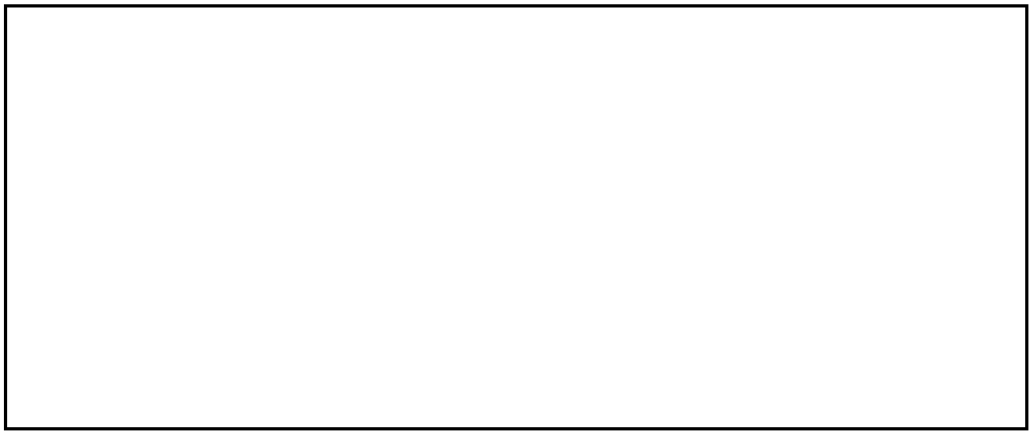

The Future of the Soviet Program

With the launching of Molniya-1 the USSR has made its initial entry into a space field dominated until this time entirely by the US. It is clear that additional launches will follow. The number of vehicles thus far involved, statements on the advantages of multiple vehicle operations, and apparent investment in ground stations indicate a significant expenditure allocated for this activity.

The success which the Soviets might have in the communication satellite field is greatly dependent on the usable lifetime of their satellites. The early

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failure of components has been a problem for the USSR and has seriously affected those ventures in which long component life is a major factor.

Though the use of Molniya-1 as a public communications satellite functioning between the USSR and other areas of the world would allow the Soviets to compete with the activities of COMSAT, it would be dependent upon the existence of suitable ground stations at the terminal points. In order to participate, a fairly large steerable parabolic antenna would be required with provision for automatically tracking the satellite. There are no indications of such installations being installed outside the USSR which may be related to Molniya-1. Facilities installed for use with US communications satellites are available in Western Europe and Japan, but equipment incompatibility would probably make their use difficult. Despite these difficulties, Soviet mastery of satellite communications technology will enable them to combat more effectively US domination of this field internationally and will certainly have an impact on existing international arrangements.

Clandestine one-way communications to the Soviet Union from abroad are a possibility and would not require antennas of the sort mentioned above. The opportunities for such communication can clearly be seen in Figure 7 showing substantial periods of common visibility of almost all points in the Northern hemisphere and the Soviet Union.

Intelligence Tasks

A number of collection and analytical tasks remain to be performed before the full story on Molniya-1 can be written.

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25X1 Further analysis of [redacted] photography together with signal intercepts is needed to clarify the details of ground station configuration and operation. This is of major importance to the search for new stations, particularly outside the USSR.

A number of other requirements remain such as the determination with high precision of the Molniya orbit and the actual weight of the spacecraft.

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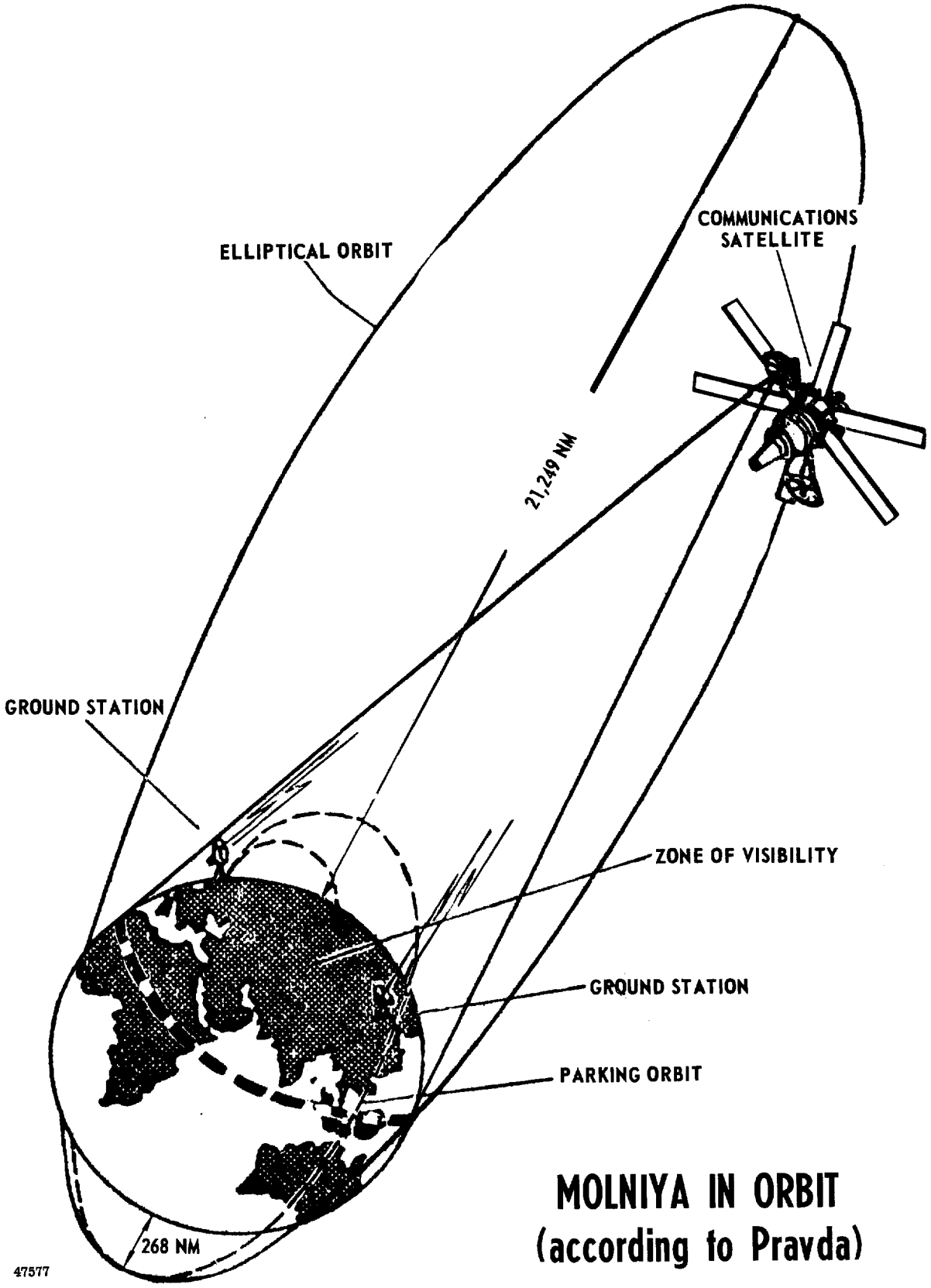
Figure 1



MOLNIYA IN ORBIT
(according to Pravda)

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CHRONOLOGY OF SOVIET COMMUNICATIONS SATELLITE PROGRAM

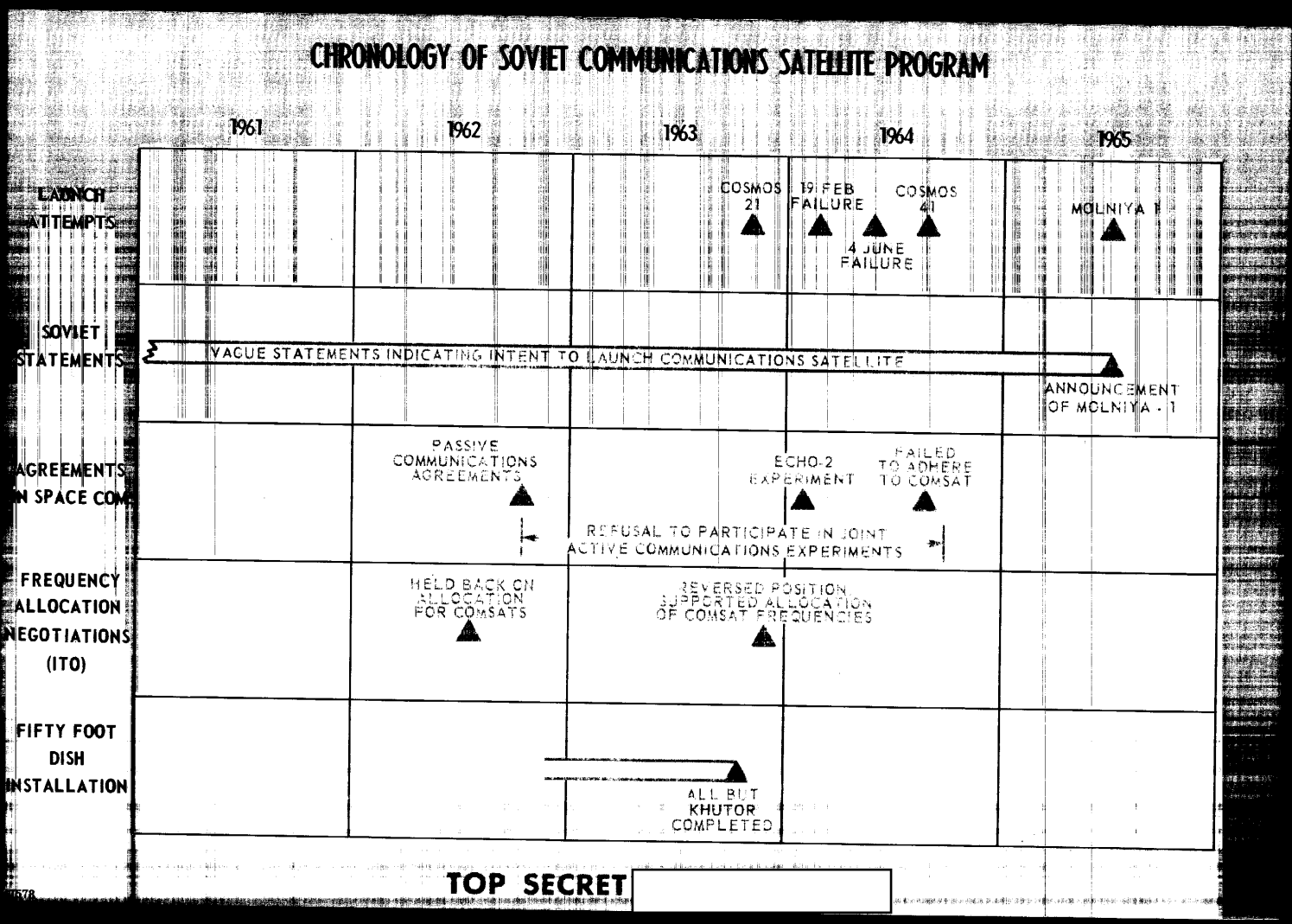

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Figure 3

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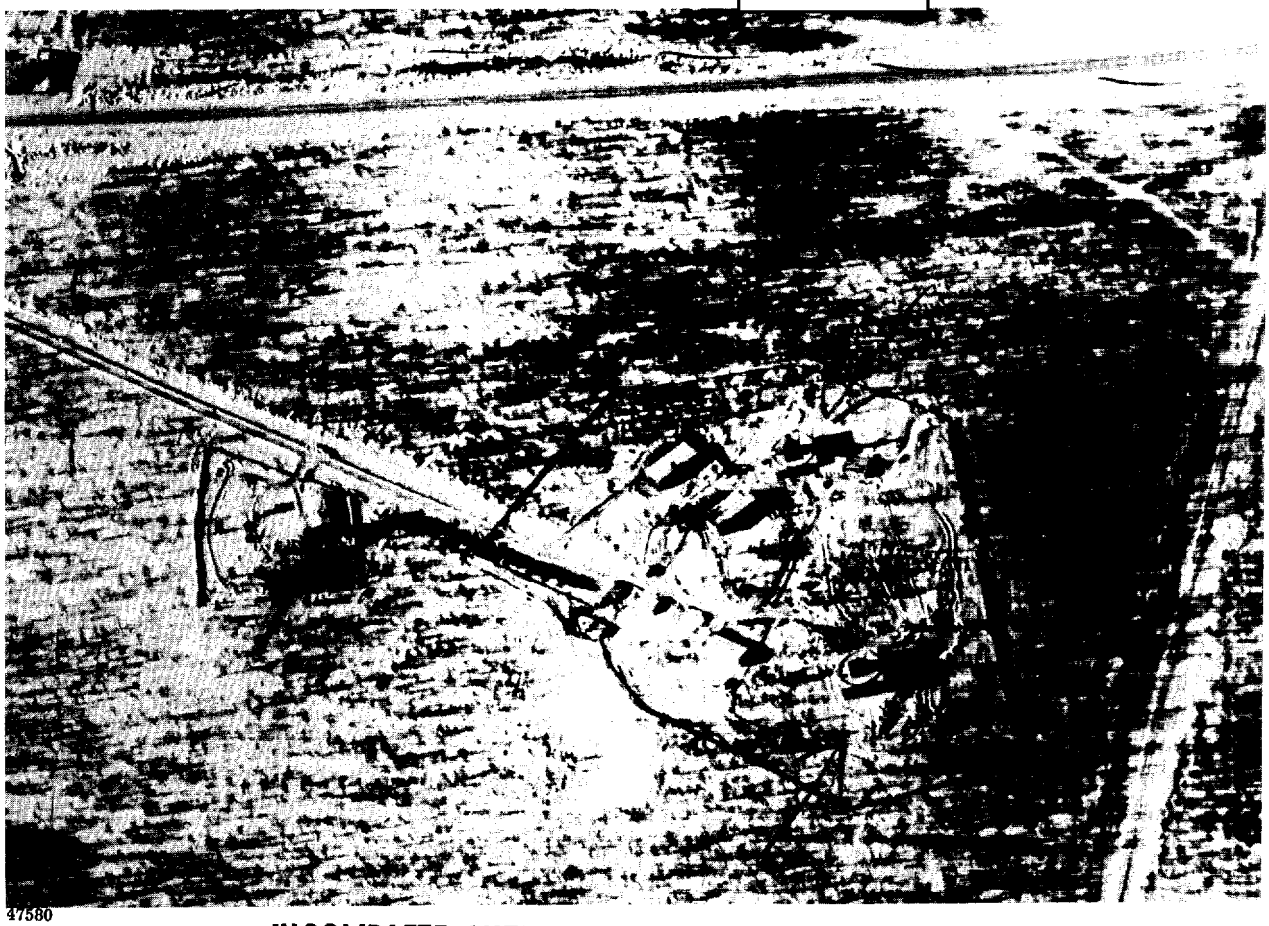

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INCOMPLETE ANTENNA INSTALLATION AT KHUTOR

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Figure 6

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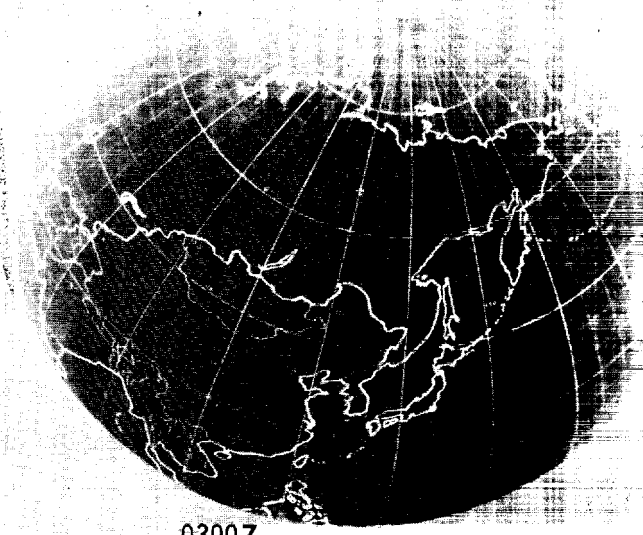
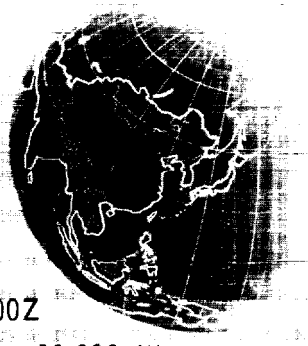
MOLNIYA-1

Earth as Seen from the Spacecraft at Four Points During Orbit 9



0300Z

Spacecraft Altitude 9500 NM
Sub-Probe Point 65 N x 120 E
Sub-Solar Point 13 N x 135 E



0500Z

Spacecraft Altitude 19,000 NM
Sub-Probe Point 45 N x 130 E
Sub-Solar Point 13 N x 105 E

0800Z

Spacecraft Altitude 21,000 NM
Sub-Probe Point 30 N x 105 E
Sub-Solar Point 13 N x 60 E

1100Z

Spacecraft Altitude 14,000 NM
Sub-Probe Point 5 N x 75 E
Sub-Solar Point 13 N x 15 E

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